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**Computer-Based Training Development and Guidance
for the Army's Unmanned Aviation Systems
Maintenance Training Division**

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August 2017

**United States Army Research Institute
for the Behavioral and Social Sciences**

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14. ABSTRACT This research developed and applied systematic principles for effective Computer-Based Training (CBT) that can be applied broadly to Army courses to build and evaluate exemplar CBT for Army advanced individual training courses. To assist cadre who do not have a dedicated instructional design team, the <i>Computer-Based Training Principles Guide</i> was developed to serve as a support tool. The guidance included here underwent iterative reviews by Subject Matter Experts during its development. This document is the resulting contents, organization, and presentation style of the <i>Computer-Based Training Principles Guide</i> and its companion User's Guide, and includes both guides.					
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COMPUTER-BASED TRAINING DEVELOPMENT AND GUIDANCE FOR THE ARMY'S
UNMANNED AVIATION SYSTEMS MAINTENANCE TRAINING DIVISION

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Computer-Based Training Development and Guidance for the Army's Unmanned Aviation Systems Maintenance Training Division

Introduction

U.S. Army course proponents and training developers often face tight training schedules that limit the number and depth of topics that can be reasonably covered in a given training program. Excluding one topic in favor of including or expanding on another may lead to deficiencies in essential knowledge and skills following graduation from initial military training. Many Army courses use Computer-Based Training (CBT), more specifically Interactive Multimedia Instruction (IMI) to enhance the efficacy of training within the time and resources allocated to them. IMI is a specific term for the presentation of training material, via computer, to the learner. In general, Blankenbeckler, Graves, and Wampler (2014) suggest that most IMI efforts appear to be piecemeal and do not seem to follow an evidence-based development strategy. The overarching goal of this current research was to develop principles and guidance for the systematic development of effective IMI that can be broadly applied to any Army course. This research supports the implementation of the Army Learning Concept (Department of the Army, 2011) by providing innovative training methods to build and deliver highly adaptable, versatile, easy-to-access, and learner-centric training of skills.

The intent of this research was to develop CBT guidance and tools to be used by Army course instructors to create and implement effective IMI, expanding upon TRADOC's Army Educational Processes Pamphlet 350-70-7 (Department of the Army, 2013). Recent ARI research indicates that there are practical CBT principles that can facilitate the design, development, and application of IMI for individualized training (Blankenbeckler, Graves, & Wampler, 2014). Other research exists for applying instructional design principles to CBT (e.g., Bowden, Gatskie, & Keller, 2001) and for CBT instructional strategies (e.g., Chen, Barbee, Muraida, & Arnold, 1994). ARI researchers reviewed these existing principles and guidelines and they were then synthesized and extended to address Soldier-centered learning. Products from this research included an easily-referenced learning theory-based CBT Principles Guide for developing effective IMI based on the Army Learning Concept. The CBT Principles Guide focuses on generalizable strategies for developing and using IMI and is supported by relevant research literature and Subject Matter Expert knowledge and experience. Subsequently, based on early reviews of the CBT Principles Guide, a User's Guide was developed to offer a more streamlined process for CBT development.

Method

Based on the CBT design principles outlined in Graves, Blankenbeckler, Wampler, and Roberts (2016), a user-friendly learning theory-based CBT Principles Guide (Appendix A) was produced to assist in-house instructors and course developers with increasing the learning effectiveness of their IMI materials developed in-house. The CBT Principles Guide provided practical examples, based on learning theory, to facilitate the integration of those principles into their in-house IMI development efforts. Previous research identified and documented some instructional design principles to enhance the learning effectiveness of CBT (Blankenbeckler,

Graves & Wampler, 2013, 2014; Graves et al., 2016). Researchers reviewed the existing CBT principles from multiple sources.

Through iterative workgroup discussions, the CBT principles were organized and grouped based on different factors (e.g., anticipated sequence in which they should be considered in the design process, significance of the impact of adhering to or not using the principle, and interrelationship between various principles). Since there was no intent to establish a definitive hierarchy among them, the CBT principles were ultimately assembled to facilitate easy access for quick reference. A very brief example of the contents and organization of the CBT Principles Guide is provided in the Results section. We developed and applied generalizable principles and guidelines for producing effective IMI in the CBT Principles Guide. Again, the CBT Principles Guide was supplemented with a User's Guide that provided additional material that expanded upon the design guidance of the CBT Principles Guide, but in a more step-by-step manner (Appendix B).

Description of Computer-Based Training Guidance

One effective CBT principle is to define the learner's task. Research shows that a demonstration of the particular whole-task similar to what the learners should be able to do following CBT instruction provides a basic orientation to training and the instructional material, as well as provides motivation for the learner (Merrill, 2002). Further guidance suggests that the CBT should show the learners the task that they are training to do as a result of completing the CBT. It is imperative that CBT engage the learner at the real-world problem or task level (Schank, 2005). One technique for providing whole-task content is to package content into smaller pieces, known as "chunking", that makes it easier for the student to assimilate and learn the material (Mayer, 2008).

Another important principle for developing Soldier-centered CBT may be the learner's control of content that varies along a continuum of learner control (Garrison & Baynton, 1987). On one end of this learner-control continuum, there are highly structured approaches that take a learner in a step-by-step manner through the learning content (i.e., designer-controlled instruction). On the other end of the continuum, learners are given autonomy in selecting the learning content for themselves (i.e., learner-controlled instruction). In the middle ground to this continuum are techniques that support well-structured learning designs but that also allow for some learner control and autonomy (Blankenbeckler et al., 2014). Further, evidence from the military and other research settings support this type of well-structured, learner-controlled design approach depending upon the knowledge, skills, and experience of the learners (Dyer, Singh, & Clark, 2005).

Garrison and Baynton (1987) describe the advantages and disadvantages of each type of controlled design. Designer-controlled CBT tends to apply to a generalized audience, provide for standardization of training, is easy to use and develop, and provides a high-level of guidance for learners that are new to a domain. Disadvantages to designer-controlled CBT are that learners progress through the content in a set sequence, take more time to complete the training, and can lose motivation. In particular, learners with higher levels of knowledge, skills and experience in the training domain may be negatively affected by this instructional design.

Alternately, some advantages of learner-controlled CBT are that it can be used to tailor to individual learners' needs, encourage students to be more self-aware during the learning process, and require learners to be more autonomous. Some disadvantages to learner-controlled CBT are that it may not be appropriate for some topic domains or for learners who are new to a topic domain. Without appropriate structure, a learner-controlled design may cause confusion for some learners, have a negative impact on learners with poor learning strategies (i.e., those who may have a more difficult time when they must take responsibility for their learning), and potentially may be more expensive and difficult to develop because of the specificity required to address different learners' needs.

Utilizing the Guides

Previous research identified and documented instructional design principles to enhance the learning effectiveness of CBT (Blankenbeckler, Graves & Wampler, 2013, 2014; Graves et al., 2016). The systematic consideration and application of sound design and development principles can lead to more effective CBT. Additionally, putting into practice these CBT design principles better supports the implementation of training that is learner-centric, more effective, and better focused on identified points-of-need. However, for the Army to realize benefit from them, these CBT principles need to be adapted to address the military audience and Army instructional needs, tailored to address Soldier-centered learning, and synthesized with practical constraints.

The CBT Principles Guide developed for this research presents the principles in an easy-to-comprehend fashion. The CBT Principles Guide was originally provided in Microsoft PowerPoint® to permit embedding of examples and supporting documents. It is intended as a quick reference guide for in-house CBT developers to design and implement effective IMI. More detail is provided in Appendix A, the rest of this section describes and highlights certain features of the CBT Principles Guide.

The CBT Principles Guide is organized into three main sections. In addition to learning theory-based principles, other useful information is presented to assist in-house IMI developers.

- The ADDIE (Analysis, Design, Development, Implementation, Evaluation) Model – A framework that guides the design and development of training (Branson et al., 1975). The ADDIE model is an accepted framework by the Department of the Army (2013). Each of the phases in the ADDIE Model is briefly explained to improve understanding of how and why this process can yield effective CBT,
- Design and Development Principles – A series of easily-referenced fundamentals that can lead to more effective learner-centric training. Each of the principles are introduced and examples are provided to demonstrate application of that principle. The principles focus on generalizable strategies and are supported by relevant research literature, expert knowledge, and practical experience. Incorporation of these principles in CBT should be situational; the goal is to design effective training, and

- Assessments – Learning is enhanced when it is assessed regularly and meaningful feedback is provided (Mayer, 2014). Samples of useful assessment and feedback techniques are provided.

Design principles contained in the CBT Principles Guide come from previous research (Blankenbeckler, Graves & Wampler, 2013, 2014; Graves et al., 2016). A list of some of the principles with a brief explanation of each is provided in Table 1.

Table 1.

Examples of Design Principles for CBT

Principle	Explanation
Define learning task	What the learner should know or be able to do after instruction
Link new knowledge	Present in context of real-world tasks and missions (problem-based)
Practice	Include opportunities to practice new knowledge and skills; present varied situations with progressive levels of difficulty
Chunks	Provide content in logical, manageable size chunks
Feedback	Provide performance feedback and tailored remediation
Promote/manage essential processing	
Segmenting	Present materials and animation in learner-paced segments
Pre-training	Provide essential pre-training
Modality	Consider narrations versus printed text
Reduce extraneous processing	
Coherence	Avoid presenting extraneous materials
Signaling	Highlight essential materials
Redundancy	Do not add on-screen text to narrated animation
Spatial contiguity	Place on-screen text next to corresponding graphics
Temporal contiguity	Present corresponding narration and animation at the same time

Table 1.
Examples of Design Principles for CBT (Continued)

Principle	Explanation
Provide a meaningful learning experience – promote generative processing	
Multimedia	Present words and pictures rather than words alone
Personalization	Present words in a conversational style rather than formal style
Voice	Put narrations and dialog in human voice rather than machine voice
Embodiment	Have on-screen agent use human-like gestures and movements
Image	Do not necessarily put the static image of agent on the screen

To maximize the use of the CBT Principles Guide, it should be viewed in the Microsoft PowerPoint® Slide Show viewing mode (see Appendix A for contact information on how to obtain the CBT Principles Guide in Microsoft PowerPoint®). Hyperlinks are provided from the Table of Contents and from index pages of design and development principles to access major sections and principles of the CBT Principles Guide. A Return button is also provided to permit quick return to the page of origin. Embedded video, documents, and audio examples can be accessed in the Microsoft PowerPoint® Slide Show viewing mode (see example on page 8 of Appendix A, Slide #14). The applications may open over the Microsoft PowerPoint® Slide Show or appear on the tray of the viewing window. They can be closed without closing the Microsoft PowerPoint® Slide Show viewing mode. An additional assist included throughout the CBT Principles Guide displays examples of what ‘right’ and ‘wrong’ might look like in an IMI module. A sample is provided on page 14 of Appendix A, Slide #26. As the CBT Principles Guide is intended to be an easy-to-use quick reference tool, brief explanations and examples are provided for each of the principles. Also, for in-house developers who want to learn more about the various principles, a list of references is included with the CBT Principles Guide for obtaining further information.

To assist in-house training developers, a Learning Effectiveness Assessment Worksheet (Appendix C) was created that can be used to assess their use of the design principles in an IMI module. The worksheet is focused on assessing how effectively sound design principles and techniques have been integrated to their IMI to enhance learning. Worksheet users should possess an understanding and working knowledge of the learning principles and techniques. The worksheet is designed to be used in conjunction with the CBT Principles Guide. Previous research has shown (Blankenbeckler, Graves & Wampler, 2013, 2014; Graves et al., 2016) that the effectiveness of IMI may be enhanced by practical application of the theory-based techniques, guidelines, and methods that are outlined in the CBT Principles Guide (Appendix A) and its supplemental User’s Guide (Appendix B).

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APPENDIX A

Computer-Based Training Principles Guide

The CBT Principles Guide is designed to be viewed in Microsoft PowerPoint® Slide Show mode. There are embedded videos and documents that can be accessed from that mode. The following pages are merely graphic images of the pages in the CBT Principles Guide and **embedded materials are not accessible here. For access to the hyperlinked slidedeck, please contact Dr. Victor Ingurgio: victor.j.ingurgio.civ@mail.mil.**

A Development Guide for Computer-Based Training (CBT): Principles to Increase Learning Effectiveness



Dr. Victor J. Ingurgio (Army Research Institute)

Paul N. Blankenbeckler & Richard L. Wampler (Northrop Grumman)

A product of the Ft. Benning Research Unit, U.S. Army Research Institute for the Behavioral and Social Sciences (ARI)

General Instructions for Use:

This Guide is provided in Microsoft PowerPoint to permit embedding of examples and supporting documents. It is designed for quick reference by CBT developers.

Run the Guide in Slide Show. Hyper navigation is provided to and from the Table of Contents and selected Index slides. Video, MS Word documents, and audio examples can be accessed in Slide Show viewing mode with the click of the mouse. The applications may open over the PowerPoint Slide Show or appear on the tray of your viewing window. They can be closed without shutting down Slide Show mode.

Hyperlinks are provided from the Table of Contents and Index of Design and Development Principles slides to access major Sections and Principles of the Guide. Return button navigation is also provided to permit quick return to the page of origin.

References are cited throughout this Guide using superscript end note numbers ^(#). These references and source documents can be found on Slide 53 listed in numerical order.

Introduction

U.S. Army course proponents and training developers often face tight training schedules that limit the number and depth of topics that can be reasonably covered in a given training program. Expanding the course is seldom an option. Excluding one topic in favor of including or expanding another may lead to deficiencies in essential knowledge and skills following graduation from initial military training, leader, or functional courses. Many Army courses have turned to computer-based training (CBT) to complement or supplement training within the time and other resources allocated to them. Some schools and courses have implemented a program of in-house development to better meet their needs.

While an excellent initiative and fruitful, these CBT efforts are sometimes less effective than desired. Course instructors or developers create the CBT on their own without the benefit of clear instructional guidance or a thorough consideration or application of proven design principles. Constrained by time, available talent, and other resources, they do not necessarily follow a comprehensive development strategy nor do their products undergo a rigorous design scrutiny prior to implementation. While these courses are beneficial, the systematic consideration and application of sound design and development principles can lead to more effective CBT. Additionally, putting into practice these design principles better supports the implementation of the Army Learning Model, providing training that is learner-centric, more effective, and better focused on identified points-of-need.

Training research has identified practical principles that can improve the effectiveness of CBT for individual training. However, these principles and guidelines need to be adapted to address the military audience and Army instructional needs, tailored to address Soldier-centered learning, and synthesized with practical constraints. This Guide bridges that gap, presenting the principles through examples, guidance, and tools that may be used by Army trainers and training developers to design and implement effective CBT.

The Guide is organized into three main sections.

- ADDIE Model – A framework that provides a guideline for the design and development of training. Each of the phases in the ADDIE Model (analysis, design, development, implementation, and evaluation) are briefly explained to improve understanding of how and why this process can yield effective CBT.
- Design and Development Principles – A series of easily-referenced fundamentals that can lead to more effective learner-centric training. Each of these principles is introduced and samples or examples are provided to demonstrate application of the principle.
- Assessments – Learning is enhanced when learning is assessed regularly and meaningful feedback is provided. Samples of useful assessment and feedback techniques are provided.

This Guide and its principles are intended to assist in the design and development of effective CBT. The principles focus on generalizable strategies and are supported by relevant research literature, expert knowledge, and practical experience. Note that incorporation of the Principles should be situational; the goal is to design effective training.

Principles to Guide the Design and Development of CBT

Table of Contents

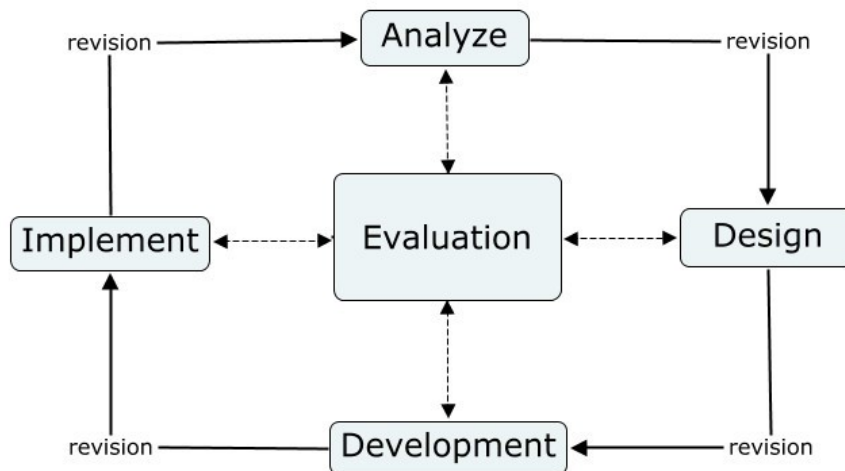
- ADDIE process (Slides 6–11)
- Design and Development Principles (Index of Design and Development Principles – Slides 12–13)
 - ☐ Define the learning task - what the learner should know or be able to do after instruction
 - ☐ Link new knowledge and skills to real world tasks and missions in context (problem based)
 - ☐ Encourage practice of new knowledge and skills
 - ☐ Provide content in logical chunks
 - ☐ Provide a meaningful learning experience–promote generative processing
- Assess student learning (Slides 46–50)

The ADDIE Model

The **ADDIE model** is an accepted framework that incorporates processes used by instructional designers and training developers.¹ It provides a guideline for the design and development of computer based training and performance support tools. It derives its name from its five phases:

- **A**nalysis
- **D**esign
- **D**evelopment
- **I**mplementation
- **E**valuation

Over time this model has been revised and is now more dynamic and interactive than the original design. Revision, adjustment and fine tuning occur throughout the process, and Evaluation have become central to each phase. The illustration depicts a simplified, revised version of the ADDIE Model.



Analysis Phase of ADDIE

The Analysis Phase clarifies and identifies the instructional target, the environment, problems, and objectives. During this phase, you should answer:

- Who are the learners and what are their characteristics? (Who are your students and what entry level knowledge and skills will they enter the course with?)
- What is the desired new behavior? (What knowledge, skills, level of proficiency, and performance are desired upon completion of the lesson or course?)
- What types of learning constraints exist?
- What are the delivery options? (Match the instructional methodologies and media to the tasks to be trained.)
- What are the pedagogical considerations?
- What Army Learning Model and/or adult learning theory considerations apply? Additionally, you must determine what you can do within time, talent, budget, and other resource constraints.

TRADOC Regulation 350-70-7 (2013) no longer prescribes particular instructional methodologies for a given subject or task. That determination depends on the learning outcomes, target audience, learning strategy, resources, and design. However, to assist with the analysis process, a previously used **Matrix of Instructional Strategies and Methods for Delivering Instruction** is provided.

Matrix of Instructional Strategies and Methods for Delivering Instruction



Matrix -
Instructional Strategi

(Open the document with a mouse click.)

The remainder of this Guide is focused on the premise that your decision was to select the **Instructional Method of Individualized, Self-Paced Instruction** or some other form of instruction using **CBT**.

Design Phase of ADDIE

The Design Phase deals with the creation of learning objectives, assessment instruments, exercises, content, subject matter analysis, lesson planning, and media selection. The design phase should be specific and systematic. Follow a logical, orderly method of identifying, developing and evaluating a set of planned strategies targeted for attaining the instructional goals. Elements of the instructional design plan must be executed with attention to details.

- Document the instructional, visual, and technical design strategy.
- Apply instructional strategies according to intended/desired behavioral outcomes by domain (cognitive, affective, and psychomotor).
- Design the graphic user interface that will provide the navigation, facilitate user interaction with the media, and set the context for the user's learning experience.
- Create a prototype (or prototypes) (Make sure your ideas work **before** you step into full production.)
- Apply the visual design and motif. (The combining of words, symbols, page layout, and images provide this graphic design. It creates a visual representation of the ideas and messages conveyed by the media. This visual design becomes the "stage" and setting that provide much of the context and orientation for the user's learning experience.)

This Guide provides principles and examples useful in the Design and Development Phases of CBT.

Development Phase of ADDIE

In the Development Phase, instructional designers and developers create and assemble content assets blueprinted in the Design Phase.

In this phase, the designers create storyboards, graphics, and audio.

Programmers develop and integrate graphics, audio, video and other content.

Testers check materials for fidelity - navigation, correct feedback, and other issues - and identify problems for edits and debugging.

The project is reviewed and revised according to feedback.



This Guide provides principles and examples useful in the Design and Development Phases of CBT.

Implementation Phase of ADDIE

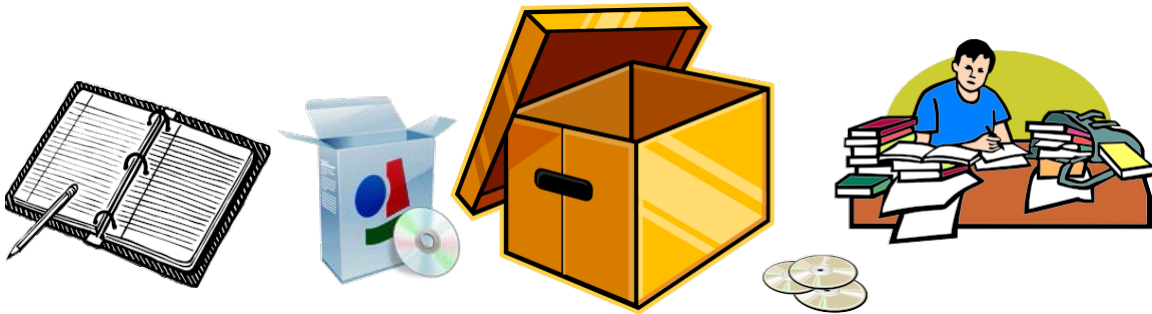
The Implementation Phase prepares training facilitators and learners to use the materials.

For example, procedures for training facilitators and learners are put in place. Training for facilitators may cover the course curriculum, learning outcomes, method of delivery, and testing procedures. Preparations for learners may include training them on new tools (software or hardware) and enrolling or registering students.

Implementation includes evaluation of the design. It may include a pilot or trial course to provide a final troubleshooting of the courseware and procedures.

Course leaders and managers may also ensure that training materials, books and manuals, equipment and tools, CD-ROMs, and software are in place.

Additionally, they may make certain that the learning applications, website functions, and learning management systems are in place and ready, if required.



Evaluation Phase of ADDIE

The Evaluation Phase has two aspects: formative and summative.

Formative assessments occur in each phase of the ADDIE process. Formative assessments may include diagnostic testing or a wide range of formal and informal assessment procedures employed by trainers during the learning process in order to modify teaching and learning activities. They have a goal of enhancing the course or courseware to increase student learning, proficiency, or attainment. They may involve qualitative feedback (rather than scores) focused on the details of instructional content, instructional methods, and course or lesson performance.

Summative assessments are focused on the learner and summarize their development or learning at a particular time or phase of the course. They are an assessment *of* learning in contrast to the formative assessment, which is assessment *for* learning. Summative assessments provide information on the lesson or course's efficacy (its ability to do what it was designed to do). Summative evaluation judges the worth, or value, of a lesson or course at its conclusion.

Evaluation continues after instructional implementation, providing feedback for minor adjustments and "tweaks" as well as formal reviews to assure that the course content remains current and continues to be effective over time.

Evaluation Phase of ADDIE

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Formative assessments occur in each phase of the ADDIE process. Formative assessments may include diagnostic testing or a wide range of formal and informal assessment procedures employed by trainers during the learning process in order to modify teaching and learning activities. They have a goal of enhancing the course or courseware to increase student learning, proficiency, or attainment. They may involve qualitative feedback (rather than scores) focused on the details of instructional content, instructional methods, and course or lesson performance.

Summative assessments are focused on the learner and summarize their development or learning at a particular time or phase of the course. They are an assessment *of* learning in contrast to the formative assessment, which is assessment *for* learning. Summative assessments provide information on the lesson or course's efficacy (its ability to do what it was designed to do). Summative evaluation judges the worth, or value, of a lesson or course at its conclusion.

Evaluation continues after instructional implementation, providing feedback for minor adjustments and "tweaks" as well as formal reviews to assure that the course content remains current and continues to be effective over time.

Index of Design and Development Principles for CBT

[Instructions: Major principles are hyperlinked for ease of access.]

- Define the learning task and objective - what the learner should know or be able to do after instruction. (Slide 14)
- Link new knowledge and skills to real world tasks and missions in context (problem based) (Slide 15)
- Encourage practice of new knowledge and skills (Slides 16 – 18)
 - ❑ Provide varied situations, progressive levels of difficulty, and lessen multi-faceted instructional support and coaching (scaffolding) as familiarity with the task and steps increase.
 - ❑ Provide performance feedback and tailored remediation.
- Provide content in logical chunks (Slides 19 – 31)
 - ❑ Promote/manage essential processing
 - **Segmenting** - Present materials and animation in Learner-paced segments
 - **Pre-training** - Provide essential pre-training
 - **Modality** - Present narrations vs. printed text
 - ❑ Reduce extraneous processing
 - **Coherence** - Avoid presenting extraneous materials
 - **Signaling** - Highlight essential materials
 - **Redundancy** - Do not add on-screen text to narrated animation
 - **Spatial Contiguity** - Place on-screen text next to corresponding graphics
 - **Temporal Contiguity** - Present corresponding narration and animation at the same time

Index of Design and Development Principles for CBT

(continued)

- Provide a meaningful learning experience – promote generative processing (Slides 32 – 45)
 - ❑ **Multimedia** - Present words and pictures rather than words alone
 - ❑ **Personalization** - Present words in a conversational style rather than formal style
 - ❑ **Voice** - Put narrations and dialog in human voice rather than machine voice
 - ❑ **Embodiment** - Have on-screen agent use human-like gestures and movements
 - ❑ **Image** - Do not necessarily put the static image of agent on the screen

Define the Learning Task, Objective, and Expected Student Performance

It is common practice to state learning objectives at the beginning of lesson materials. For example, learning objectives usually take a form like: "The learner will be able to" However just stating the learning task, objective, and/or performance standard is often not adequate.

Learning objectives presented as an abstract statement are often only understood by the learner following the instruction. They do little to set the context or engage the learner's attention. Research shows that a demonstration of the particular **whole task** similar to what the learners will be able to do following instruction provides a much better orientation to training and instructional material as well as provides motivation.²

Show the learner the task that they will be able to do or the problem they will be able to solve as a result of completing a module or course. Engage them at the real world problem or task level, not just in a task step, operation, action, or procedure.³

This video clip provides a model, an example of a lesson for the tactical task – **Conduct Immediate Suppression**. This example provides a motivating introduction that demonstrates the whole task. It then presents the learning objective.



Link New Knowledge to Real World Tasks and Missions

Training research shows that learners assume ownership, that is apply themselves to learning and show enthusiasm, when problems to be solved are interesting, relevant, and engaging. Introduce the whole task, problem, and/or real-world application – EARLY.²

WHAT NOT TO DO

Topic Centered Instruction often introduces subtasks or components of a task in isolation. The subtask or component is never related to the whole task. Trainers sometimes tell the students, “You won’t understand this now but later it will be really important to you.” Students are taught the prerequisites before any introduction of or link to the real world application/whole task.

WHAT TO DO

Problem-Centered Instruction stands in contrast to this watered-down approach. Learning is best promoted when learners are **engaged** in solving a real-world **problem**. The **problem** includes a wide range of activities, the most critical characteristic being that the activity is part of some whole task rather than only a component of a task and that the task is representative of situations that the learner will encounter in duties and assignments following instruction.

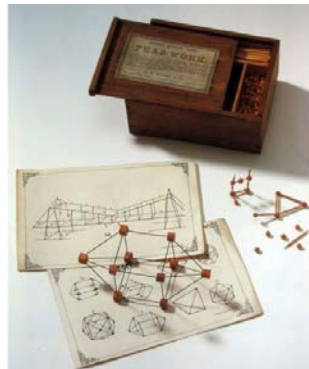
The early linking of new knowledge and skills to real world tasks and missions provides motivation, an immediate reason to learn new skills or gain new knowledge, as well as the context for future use and application.

Learning to complete a whole task involves four levels of instruction and student performance:

1. The problem
2. The tasks required to solve the problem
3. The operations that comprise the tasks
4. The actions that comprise the operations

The most effective instruction engages students in all four levels of performance. It provides a context and explains to the student **early** how the tasks, operations, and actions interrelate and why they are important.

This vintage erector set employed this **Principle**. It taught the “future engineer”:



- The use and value of basic building components
- How components contributed to construction of fundamental geometric shapes
- The engineering characteristics of basic geometric shapes
- The relationship of these shapes to the successful construction of large complex structures, such as bridges and buildings.

Encourage Practice of New Knowledge and Skills

Learning is doing.² The old saying that “practice makes perfect” has validity. However, for practice to be effective it should follow some basic rules:

- Students learn when they use their new knowledge and skills to solve problems.
- Practice (and tests) should be consistent with stated learning objectives and performance standards of the task, for example:
 - ❑ Learners recall or recognize information about or related to the problem (or subtask or component of the problem).
 - ❑ Learners locate, name, describe, or identify components or parts.
 - ❑ Learners identify new examples of components, parts, or elements.
 - ❑ Learners perform procedures
 - ❑ Learners:
 - Predict the consequences of an action, when given the conditions and/or circumstances.
 - Troubleshoot or determine a fault when given an unexpected consequence or failure.

- Practice and problem solving should be initially supported by scaffolding – error detection, feedback, and coaching. However, coaching and other instructional support should be gradually withdrawn as the student gains proficiency and confidence.

Note that all of the examples have the learner doing something, not memorizing and regurgitating what they were told.

Making mistakes in practice is okay. Students learn from making errors, **if** they are shown how to:

- Recognize the error
- Recover from the error
- Avoid the error

Applying new knowledge in a single problem is insufficient, especially when learning a cognitive skill.³ Practice should provide a range of application opportunities with varied conditions, situations, and increasing levels of difficulty for the new learner.

Encourage Practice of New Knowledge and Skills *(continued)*

Allow the student to practice the skill, not the same problem or context.

What practice isn't.

Practice is not introducing a concept or step using a demonstration in a context, then:

Being provided examples in the same or very similar context.

Performing the same step (repetition) again and again in the same context.

Working through a quiz or check on learning in the same context or situation.

Encountering the same or similar problem and context in an end of section or final exam.

The learner now *may* understand how to solve one (1) problem with the new skill.

What practice *should be*.

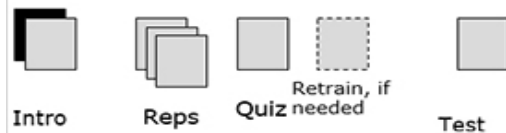
Practice is having a concept or step introduced using a demonstration in a particular context.

Providing examples in similar but varied contexts.

Performing the steps to solve different related problems of increasing difficulty, in varied contexts.

Working through different but related problems in a quiz or check on learning.

Encountering different but related situations and problems in an end of section or final exam.



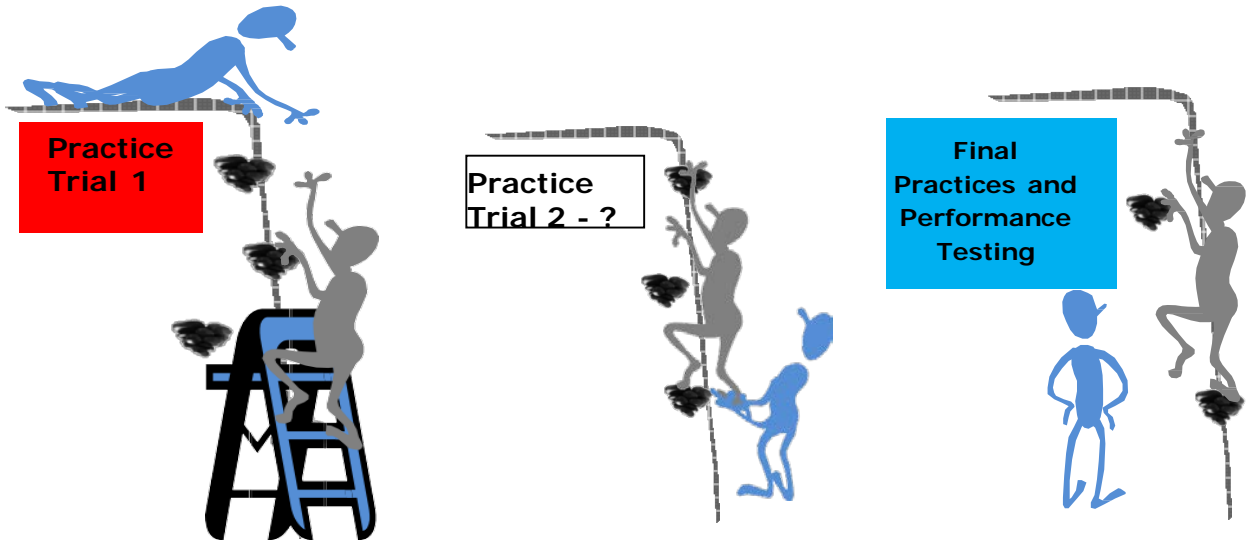
Can solve a problem in a single context, maybe.



Diverse problems, with increased difficulty and varied contexts

Can solve related problems in varied contexts

Encourage Practice of New Knowledge and Skills (continued)



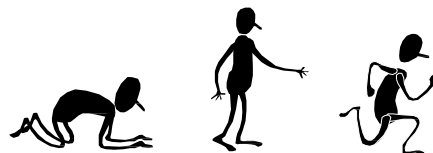
To help the learner master a complex problem, start with fewer conditions and less complexity. Error detection, hints, and corrections can be provided. The trainer or media may intervene or guide the learner.

As simple problems are mastered, instructor/media support should be reduced, and the complexity and/or conditions of problems increased.

Retraining on certain aspects of the task may be required.

Through a progression of increasingly complex problems, learner skills and confidence increase. As greater complexity is introduced, instructor/media scaffolding is withdrawn.

In simple Army training terms, employ:



Crawl

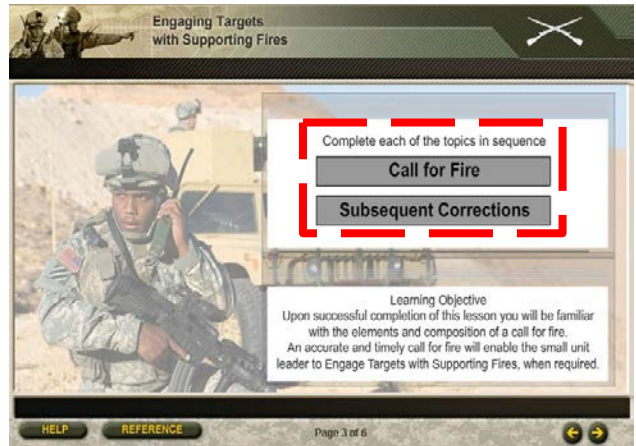
Walk

Run

Provide Content in Logical Chunks

This principle focuses on packaging content into “bite size” pieces in a framework and order that will be easier for the user to assimilate and learn.⁴ The principle employs techniques that will:

- **Foster and manage essential processing** – avoid overloading the learner. Focus the learner’s cognitive and mental capacities on building a coherent mental representation.
- **Reduce extraneous processing**
 - eliminate or minimize distractions and extraneous processing that waste cognitive capacity and detract from the learner’s ability to build an appropriate cognitive representation.



Chunked Content – provides learner with structure, but also supports flexibility. It eases navigation and provides high-level structure to support ease of understanding and assimilation.

Chunking content is a great start. However, learning efficiency and effectiveness are further enhanced when techniques are incorporated that **manage essential processing** and **reduce extraneous processing**.

Provide Content in Logical Chunks – Manage Essential Processing

A learner can quickly be overwhelmed by the complexity of new ideas, knowledge, and skills:

- Short term memory can become overloaded.
- New knowledge may not relate to or associate with existing knowledge.
- Misconceptions may develop.
- The number of elements of new information and the relationships between them may not be apparent.

Cognitive overload causes confusion and frustration. It can disrupt the learner's ability to build a coherent mental representation. However, the mission of your CBT is to train the student; you can't just "dumb down" the materials, delete, or omit complex pieces to make learning easy. You can employ techniques and principles that help the student to better cope with and/or control the learning process.

There are three principles associated with **Managing Essential Processing**.⁴ These principles reduce or eliminate the potential for cognitive overload. They are:

- **Segmenting** – Present the animation and material not only in chunks, but in learner-paced segments. Provide a means to control the pace of presentation.
- **Pre-training** – Provide training on essential prerequisite knowledge and skills required in primary training lessons and modules, for example, names, locations, and characteristics of key components.
- **Modality** – Present key ideas in spoken text, narration or dialog – something for the learner to hear, rather than merely written text for the learner to read.

Manage Essential Processing - Segmenting

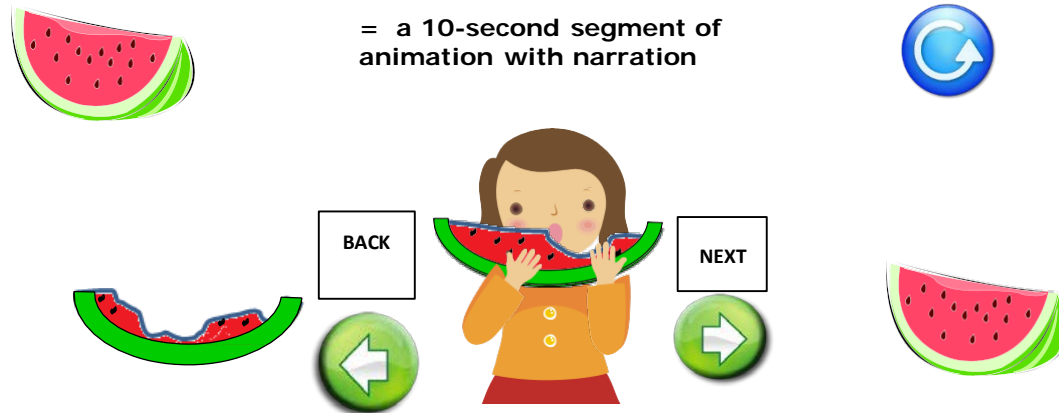
Segmenting is similar to preparing to eat a watermelon. It makes less of a mess and is easier to consume and enjoy if it is cut into small pieces.



Continuous presentation (automatic navigation from frame to frame) may be appropriate for some introductions or the lead-in for a scenario. However, for the presentation of training, “learner-controlled” navigation and smaller chunks of multimedia instructional material should be the rule.

Training research focused on training complex subjects indicates that dividing the presentation into +/- **10-second segments** (animation with narration) proved effective.⁵ The effectiveness was further enhanced by providing the learner with control of presentation rates and the chance to repeat segments through **NEXT** and **BACK** navigation buttons.

These features most benefit students with low working memory capacity. Additionally, they provide high achieving learners with the ability to rapidly advance. All learners can progress at their own pace. Students can go **BACK** if they didn't quite get it or select **NEXT** and advance at a more rapid pace if they grasp the materials. Offering a page or narration **REPLAY** feature also benefits new learners and those with low working memory.



Manage Essential Processing – Pre-training

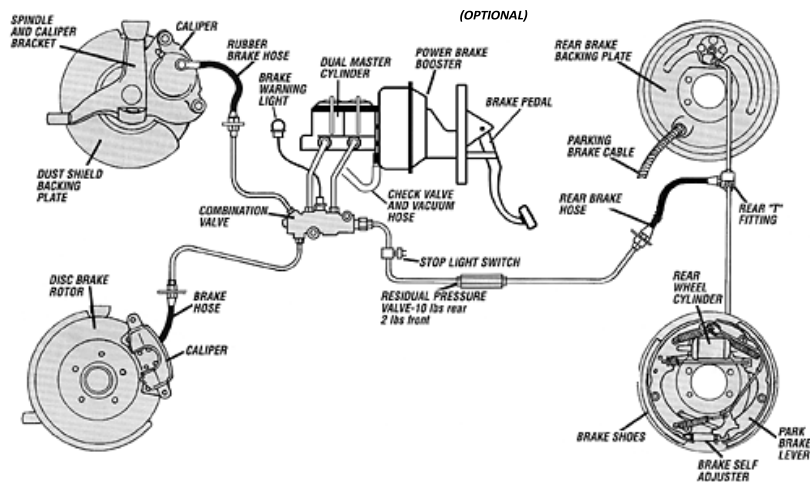
Students learn more deeply from multimedia when they have obtained the necessary foundation knowledge and skills.⁵ This foundation or prerequisite knowledge and skill may include such things as:

- The names and characteristics of main concepts
- The names, locations, and characteristics of key components in a system
- Tools to be used when performing the task
- Map reading or land navigation skills

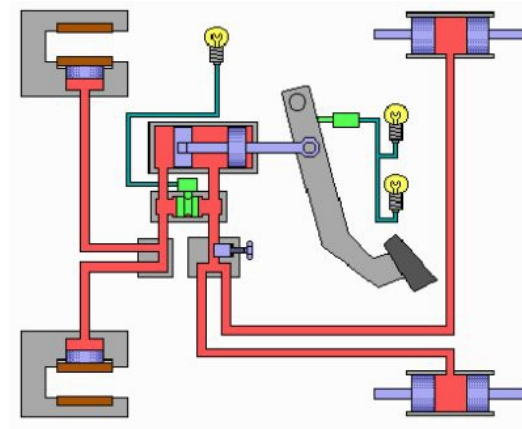
Pre-training is intended to manage essential mental processing during the course of training. For example, students already familiar with the names, locations, and functions or behaviors of components can devote more of their cognitive capacity to building a coherent mental representation or a cause-and-effect model of a system.

For example, training on troubleshooting a hydraulic brake system would be enhanced by **Pre-training** on the names, locations, and characteristics of the key components of a brake system.

Components of an Automobile Hydraulic Brake System



Troubleshooting a Hydraulic Brake System



Manage Essential Processing – Modality

Students learn better from graphics with narrations and graphics or animations rather than graphics or animations with printed text.⁴

- When graphics and animation are paired with on screen text, learners experience ***split attention***. When they view the graphics or animation they cannot look at and read the text. When they read the text they cannot view the graphics or animation. Trying to view both causes incoming essential information to overload the learner's visual channel.
- Pairing animation and graphics with narration offloads the processing of spoken words (narration) from the visual channel to the verbal channel.
- ***Split attention*** also occurs when the wording of narrations and necessary on-screen text have only slight variations. Vary the necessary on-screen text from narrations.

Context Notes:

Create multimedia instruction – not a book in a box.

Some on-screen text may be needed to:

- Reinforce a key point
- Provide safety cautions or hazard warnings

However, DO NOT use extensive on-screen text as a substitute for pre-training, additional media (more pages or frames), or when offline supplemental reading, references, or exercises would provide a more appropriate learning opportunity.

See an example on the next slide.

Manage Essential Processing – Modality

(continued)

This video (inactivated) provides an example that could easily transition into CBT. Narrations and animations are very sparsely supplemented by on-screen text. Narrations and animation provide the primary instructional content.



Provide Content in Logical Chunks – Reduce Extraneous Processing

Since a learner can quickly be overwhelmed by the complexity of new ideas, multiple steps, knowledge, and skills, it is critical to not only manage essential processing, but also to guard it by reducing or eliminating extraneous processing. This can be accomplished by keeping the learner's attention (eyes and ears) focused through effective learning techniques, and by:

- Limiting or eliminating distractions or unnecessary details that are a waste of cognitive capacity.
- Minimizing the disruptions of the learner's effort to build an appropriate cognitive representation.

Cognitive overload causes confusion and frustration. Your media design should employ techniques that help the student to better cope with and/or control the learning process. There are five principles associated with **Reducing Extraneous Processing**.⁴

These principles reduce or eliminate the potential for cognitive overload.

- **Coherence** – avoid insertion of materials that are not essential to building the learner's mental model.
- **Signaling** – draw attention to essential materials. This can be done with narration emphasis, highlighting, and drawing attention to essential on-screen text.
- **Redundancy** – avoid duplication in narration and on-screen text. Duplication may contribute to cognitive overload.
- **Spatial contiguity** – provide a logical layout and organization on pages and frames of material. Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
- **Temporal contiguity** – present narrations synchronized with animations. Students learn best when actions in animations and narrations are in step and narrations address ongoing actions; present graphics and corresponding narrations at the same time.

Reduce Extraneous Processing – Coherence

Students are better able to focus their attention and capacities on essential material when extraneous materials that could distract them are eliminated.⁴ They learn more deeply when extraneous materials are excluded. The page design and supporting graphics should focus on key learning objectives. Avoid the temptation to introduce remotely related, unnecessary, or “nice to know” information in any form: animations, video, text, or images.

Coherence Examples

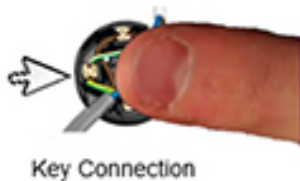
Extraneous materials on the screen have an influence similar to texting while driving. However, instead of “distracted driving”, the result is diverted attention and disrupted learning.



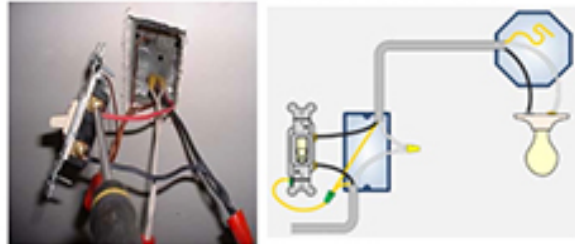
Symbols and metaphors may contribute to learning, if understood by the learning audience. If not understood, they can be terrible distractions.



Simple graphics for pointing provide less distraction and better accuracy than fingers or human gestures.



Clean diagrams and graphics are easier for the new learner's eyes to navigate than cluttered photos.



[Grab your reader's attention with a great quote from the document or use this space to emphasize a key point. To place this text box anywhere on the page, just drag it.]

Reduce Extraneous Processing - Signaling

Students are better able to focus their attention and capacities on key or essential learning material when it is emphasized. **Signaling** may be achieved through:

- Narration - - Tell'em that it is important.
- Illumination or highlighting
- Underlining, **bolding**, or *italics* (or a **combination**)
- COLOrS, **FlashingTextt**, or **WARNINGs**

Methods that attract and focus the learner's attention.

However, focus the learner's attention, *but*
Don't Over Do It!



Reduce Extraneous Processing – Signaling *(continued)*

More subtle techniques (fewer extraneous distractions) will result in better success. Use framed text boxes and chose fonts that focus the learner’s attention.⁶ Be consistent with signaling techniques; learners “catch on” and are alert to techniques consistently used. The insert below provides details for using the simple method of font selection for **signaling**:

Fonts are sometimes selected for use in multimedia designs for their readability or esthetic qualities. For example, Arial, Verdana, or Helvetica are neat, defined, and clean san serif fonts. These fonts are frequently selected for titles, short bullets, and captions (on-screen text). They are ideally used when there is not too much text and readability is not an issue.

However, studies indicate that font selection has a significant impact on student’s ability to recall information. Serif type fonts, those with a finishing mark, embellishment, or a line at the end of a stroke in a letter or symbol, can improve recall by approximately 9%. This improvement has practical value. On-screen text in a serif type font can be used to support the conveyance of key teaching points or to emphasize safety information when training new skills or knowledge.

What accounts for this increase in recall when using serif fonts? While san serif typefaces are clean and bold, they are slightly less legible than serif faces. The serif fonts seem to make rows of text appear to set upon a line. These more distinct rows of text may be perceptually easier to separate. This same effect is often achieved when a reader uses a straightedge, underlines, or highlights a section of text. These techniques more clearly separate the target text from the surrounding text and information.

More easily perceiving a row of text makes the text easier to read. Less attentional resources are required for the process of reading and more attentional resources can then be devoted to attending to the message or information being conveyed. This may result in deeper processing and an easier recall of the information.



Font	Type	Size	Example
Times New Roman	serif	14	One, two, three
Palatino	serif	14	One, two, three
Courier	serif	14	One, two, three
Monaco	san serif	14	One, two, three
Verdana	san serif	14	One, two, three
Helvetica	san serif	14	One, two, three
Arial	san serif	14	One, two, three

Reduce Extraneous Processing - Redundancy

Displaying the narration in on-screen text, potentially increases cognitive overload. Learners are better able to focus their attention and capacities on key material or essential learning when the incoming verbal materials are reduced to a single stream.^{4, 5} While it may seem that providing both a narration and parallel on-screen text would be helpful since some learners prefer to read and some prefer to listen, the opposite is true. Adding on-screen text creates extraneous processing. The learner tries to reconcile the two incoming verbal streams reducing cognitive capacity and deep learning.

Images or animation and narration alone prove more effective in learning. However, when some on-screen text is required for clarification, additional details, or emphasis, consider:

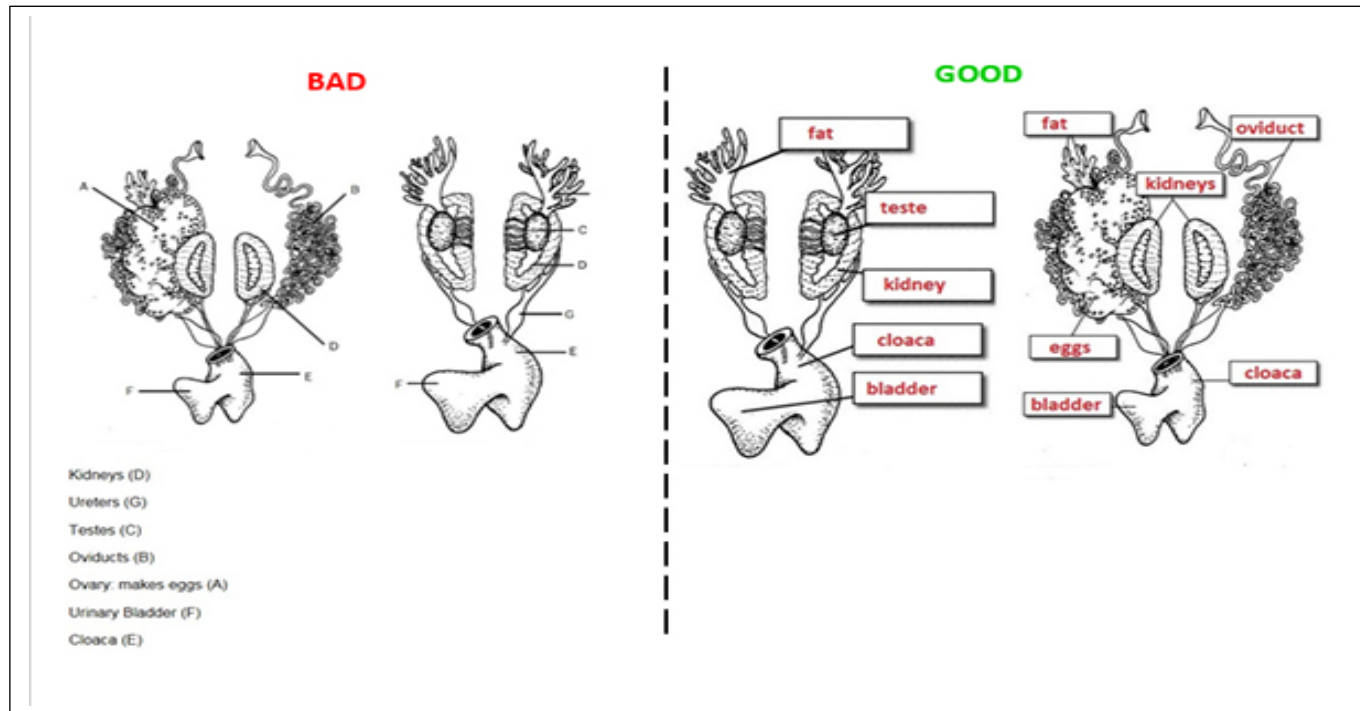
- Adding media – another frame or two. . . or three
- Assure dissimilarity of on-screen text and narrations
- Use short bullets (not more than 3 – 4 concise phrases)
- Phase in the on-screen text - - after the narration and animation

(NOTE: The short list of bullets above is an example.)

Reduce Extraneous Processing – Spatial Contiguity

Students learn better when corresponding words (on-screen text) and pictures are presented near rather than far from each other on the page or screen.⁴

Spatial Contiguity applies to captions, labels, and explanatory text associated with pictures, images, and graphics. While the urogenital systems of frogs may never be the focus of your CBT, these contrasting images and labeling schemes provide examples.



Reduce Extraneous Processing – Temporal Contiguity

Students learn best when actions in animations and narrations are synchronized.⁴ Present graphics and corresponding narrations at the same time and synchronize the descriptive words with the actions that the learners are viewing.

Temporal Contiguity applies to synchronization of narrations with animations or videos. Most of us have watched a “B grade” Kung Fu movie or foreign made Western. These low budget movies have dubbed English dialog and sound effects over the original sound track. Some display continuous subtitles during the foreign dialog. Occasionally the actor’s lips keep moving after a sentence ends, or they stop moving while the overdubbed dialog continues. Sometimes the slap of a sharp blow occurs before or after your eyes tell you that the blow is landed.

While humorous in the “B grade” action movie, animations and narrations in multimedia instruction delivered out of synchronization or disconnected have a negative impact on the learner. The result of this visual and verbal disconnect is often misconception or cognitive overload as the learner’s cognitive capabilities busy themselves trying to make sense of the disjointed presentation.



Provide a Meaningful Learning Experience – Promote Generative Processing

Knowledge construction relies on active mental processing of perceptions, what the learner sees and hears. This active mental processing is commonly referred to as **Generative Processing**. Its end result is understanding. If your instructional design and presentation techniques have been successful in **Reducing Extraneous Processing** (*slide 20*) and **Managing Essential Processing** (*slide 25*), you have freed up the learner's cognitive capacity. There is now cognitive capacity for **Generative Processing**, mental processing potential for knowledge construction and understanding – **real learning**.^{4,7}

However, this doesn't just happen. Your design should facilitate the learner's engagement in **Generative Processing**, otherwise some or all of this available cognitive capacity will remain idle. Techniques that promote **Generative Processing** include:

- **Multimedia** – present learning materials in words and pictures (graphics, images, video, and animation), not just words alone.
- **Personalization** – present words and narrations in a conversational style rather than formal style. Your narrator should develop a “social partnership” with the media in talking to, not at the learner.
- **Voice** – narrations should be vocalized in a manner that is human and avoids the impression of machine or synthetic voice.
- **Embodiment** – on-screen agents (characters, images, and animations) aid in the learning process when they display human-like gestures (movement, eye contact, and expressions). Human-like actions create a sense of social presence that learners relate with and react positively toward.
- **Image** – static images of a speaker (e.g. narrator) on the screen may cause a distraction.

Promote Generative Processing - Multimedia

CBT should employ the power of multiple forms of media (graphics, images, video, audio, animation, and text) to engage the learner through sight and sound and support the learner's active mental processing of the perceptions and information conveyed by the media.⁴ While the learner may be limited to some extent by physical interfaces, the array of media and interactive programming can bring the learner into a near virtual environment. To reduce this experience to words alone is an injustice. Without graphics and other media, CBT is just a "book in a box".

With inputs from the verbal channel, limited generative processing is possible. Cognitive capacities are idle while learning and understanding become more difficult.

Example: You are on a mountain road in East Tennessee near Richardson Cove crossroads. It is getting dark, a storm is coming, and you need to get to your destination in Pine Grove, a few miles away. You query your smart phone for directions, but all that you can get are written directions. Good luck.

(View the details then advance for more).

Start out going west on Richardson Cove Rd toward Maples Branch Rd.	0.3 mi
Take the 1st left onto Maples Branch Rd.	0.05 mi
Turn right onto Pittman Center Rd/TN-416.	1.5 mi
Turn left onto Birds Creek Rd/TN-454.	0.1 mi
Take the 1st right onto Upper Middle Creek Rd.	5.4 mi
Upper Middle Creek Rd becomes Dollywood Ln.	0.7 mi
Turn left onto Dollywood Ln/TN-449.	0.3 mi
Turn right onto Parkway/US-441 N/US-321 S/TN-71. Continue to follow Parkway/US-441 N/TN-71.	2.9 mi
Turn right onto Showplace Blvd.	0.01 mi
Welcome to PINE GROVE, TN.	

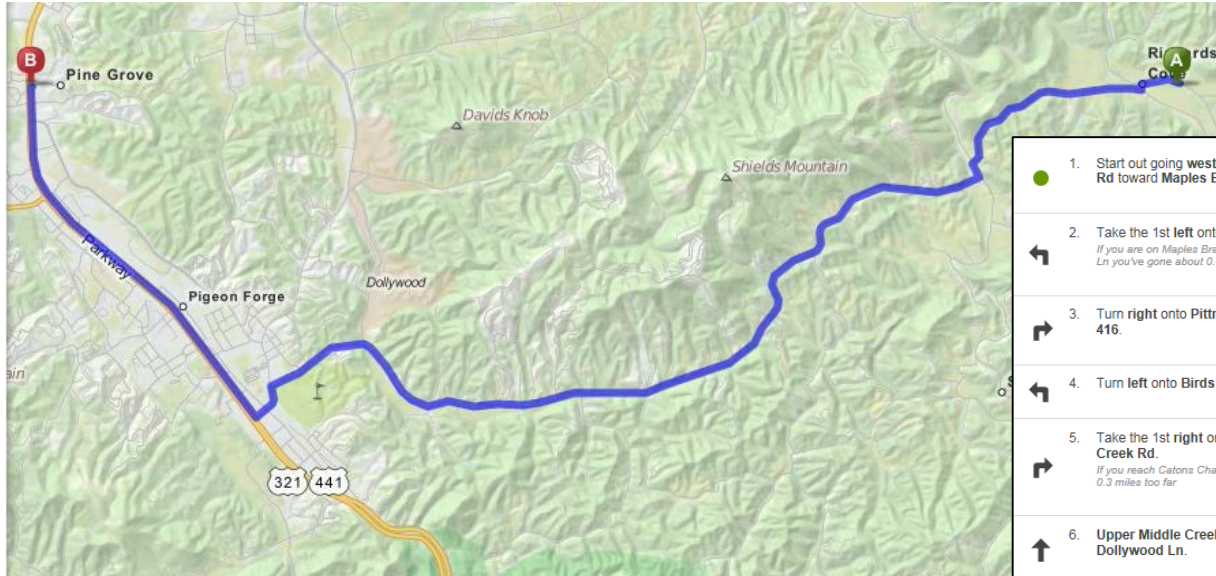


The driver's view through the windshield of a crooked Smokey Mountain road.

Promote Generative Processing – Multimedia

(continued)

You try again. This time the graphics come with the words.




1.	Start out going west on Richardson Cove Rd toward Maples Branch Rd .	0.3 mi
2.	Take the 1st left onto Maples Branch Rd . <i>If you are on Maples Branch Rd and reach Laurel Ln you've gone about 0.4 miles too far</i>	0.05 mi
3.	Turn right onto Pittman Center Rd/TN-416 .	1.5 mi
4.	Turn left onto Birds Creek Rd/TN-454 .	0.1 mi
5.	Take the 1st right onto Upper Middle Creek Rd . <i>If you reach Catons Chapel Rd you've gone about 0.3 miles too far</i>	5.4 mi
6.	Upper Middle Creek Rd becomes Dollywood Ln .	0.7 mi
7.	Turn left onto Dollywood Ln/TN-449 .	0.3 mi
8.	Turn right onto Parkway/US-441 N/US-321 S/TN-71 . Continue to follow Parkway/US-441 N/TN-71 . <i>Parkway is 0.1 miles past S River Rd Pizza Hut is on the corner</i>	2.9 mi
9.	Turn right onto Showplace Blvd . <i>Showplace Blvd is 0.1 miles past Sugar Hollow Rd Hampton Inn & Suites Pigeon Forge On The Parkway is on the corner If you reach Plaza Dr you've gone a little too far</i>	0.01 mi
10.	Welcome to PINE GROVE, TN .	

Graphics and words (synchronized information on the visual and verbal channels) have a very positive impact on understanding.

You just might make it from Richardson Cove to Pine Grove now.

Promote Generative Processing – Personalization

Narrations and dialog should be presented in a conversational rather than formal style.⁷ This is a bit more than replacing “the” with “your”, it may require some thought. However, research shows that when conversational or “polite” wording is used, the learner develops a sense of social partnership with the narrator. Within that “social partnership” the learner tries harder to make sense of what his conversational partner is saying and trying to convey. Learners process the key points of the dialogue and the result is a better transfer of knowledge and skills from the media. The two narration examples below provide parallel narratives on a procedure of watch repair. They provide a contrast of conversational vs. formal styles.

Conversational or “Polite”		Formal
<p>Now that you have opened the back and accessed the “guts” or movement of the watch, your next step is “letting down” the mainspring. The mainspring is a long piece of steel. It is rolled up and held tightly inside a cylinder called the “mainspring barrel”. In this state the mainspring is under constant pressure. It is a rigid ribbon that wishes to lay flat and not be rolled up. When you wind a watch, the mainspring rolls even tighter, storing the energy needed to run the watch. Your task is to make sure that the watch mainspring is not under pressure. You do this by “letting down” or unwinding the mainspring. Taking a wound watch apart could not only damage the watch but may send pieces flying around your work area. The proper way to “let down” the mainspring is a bit tricky. First, wind the watch a bit so you can observe the moving parts and locate the “click”. The “click” is a tiny metal stopper that clicks every time that it passes over a gear.</p>	<p>Identify and disengage the “click” to let down the mainspring of a watch.</p>  <p>Better style for CBT narrations</p> <p>Okay for written technical directions</p>	<p>The watch back is now removed and the movement or “guts” can be accessed. The next step is “letting down” the mainspring. The mainspring is a long, flat ribbon of steel. It is tightly coiled under pressure and contained inside a cylinder called the “mainspring barrel”. When a watch is wound, the mainspring is rolled tighter, storing the energy needed to run the watch. Before proceeding further, the energy must be released from the mainspring. This is accomplished by unwinding the watch in a process called “letting down” the mainspring. The mainspring must be “let down” to avoid damage to the watch. This damage can sometimes be calamitous with delicate parts breaking and detaching from the movement. Therefore, the process of “letting down” the mainspring is delicate and complex. The process begins by slightly winding the watch while observing the movement to locate the small metal stopper or “click”. This small stopper emits a “click” sound every time that it passes over a gear.</p>

Promote Generative Processing - Voice

Training research indicates that human voice narrations and dialog promote generative processing in learners better than machine synthesized (text-to-speech) voice.⁷ The human voice with its tone, inflection, and familiar qualities elicits a sense of social familiarity in learners. While this is no doubt true, there are some questions that should be carefully weighed when producing CBT on a constrained budget:⁸

- Why consider machine synthesized voice – text-to-speech (TTS)?
- Why not use human narration?
- What are some considerations for just using on-screen text?
- How will the narration affect the quality of the learning? How will students accept the voices?

Why Use Text-to-Speech?

- It is the cheapest and fastest method to produce narration; it can be done in-house with commercially available software (a one-time expense).
- The voice quality and variety of TTS has improved in recent years; it is widely used and employed in the training and information programs of major corporations. It has matured beyond the “mechanized sound” and “robotic cadence”; TTS voice can be “trained”.
- It is easily integrated into CBT with minimal programming.
- It is the easiest method of narration to revise on-the-fly and update; the software permits quick edit of voice speed, single words, and spellings can be modified (trial and error method) to incorporate military jargon and pronunciation of acronyms.
- A computerized voice is generally consistent in pronunciations and speaks at a steady pace. These qualities allow most learners to understand the material more easily (especially when English is not the student’s primary language).
- It provides a quick and easy means to listen to and assess scripts.
- Some recent research indicates that TTS is “good enough”; it is accepted by students, and does not detract from learning.

Promote Generative Processing – Voice

(continued)

Why not use Human Narration?

- Live voice narrations are expensive and time-consuming to produce; they require specialized equipment, facilities, and talent. Requirements are frequently out-sourced.
- They are difficult to produce since only a few people have the voice quality and minimal accents to perform the recordings. This creates an initial resource constraint for the creation of material.
- Live narrations are significantly more complicated and costly to update; they require the use of the original voice talent for most minor edits or when changing large sections of narration.
- Most raw recording requires some minor edits. Unedited recordings sometimes retain pacing issues (too fast or too slow), sound quality issues, incorrect pronunciation, or improper voice emphasis. Corrections could require redoing an entire narration sentence or segment.

Why not just use on-screen text?

- Most learners have much better vocal/listening comprehension than reading comprehension skills.
- Audio contributes to more effective learner engagement.
- Large amounts of on-screen text would be required to support instructional graphics or animations; narration better augments graphic materials and enhances learning.
- Text limits the opportunity for human emotion and voice emphasis.
- Text alone can be very boring and mundane.

Promote Generative Processing – Voice

(continued)

Summary

- TTS is the cheapest and fastest method to produce narrations and to make revisions/updates.
- When TTS is used, including a caveat at start of training may help to set student expectation about computer voice.
- When TTS is used as the primary source of narrations, selected segments, on-screen characters, and scenarios that benefit from “emotion” and voice inflection can be developed in live voice to enhance learning objectives while reducing expense.
- However, consider methods and techniques that best address the needs of your learners:
 - Learners who derive more from reading than listening sometimes advocated for a narration mute button with script available on-screen. This enhances the learning of those who prefer that modality.
 - Narration with pop-up on-screen text may be preferred by those for whom English is a second language. Some learners in this category have indicated that this technique helped them learn English.

Examples are provided on the next slide.

Promote Generative Processing – Voice

(continued)

EXAMPLES

For your comparison, variations with narration texts are provided:

"Breathy, conversational"
TTS



In my younger days, the older sergeants told me that if the Army wanted me to have an attitude, they would have issued me one. However, attitudes are a fact of nature. As NCOs and leaders, we know it is much easier to motivate Soldiers to do things that they enjoy and understand. It is always more difficult if they don't enjoy the task, or (Pause) they feel pressured. In this example, Sergeant Golden is meeting with his Platoon Sergeant. Listen in; the news is not all good. Sergeant Golden's "to do list" is about to get longer.

"Dialog" Live Voice



SFC Ivy: SGT Golden, I have some good news and some bad news, which do you want a first?

SGT Golden: Just give it to me straight Sergeant Ivy.

SFC Ivy: Okay. The First Sergeant was just alerted that your squad leader, Staff Sergeant Black, is being reassigned to the Old Guard. He will be clearing within a week. Your squad has been tops in the Company, maybe the Battalion. You are junior, but you have played a **major role** in that good performance. You have demonstrated a lot of potential. The Platoon Leader and I thought that we'd just move you up, but the First Sergeant says that there are two more E (say the letter "e") fives in the Company who deserve a chance, Marsh in 3rd Platoon and Wilson in 2nd Platoon.

SGT Golden: (in a frustrated tone) Come on Sergeant Ivy; isn't Wilson the guy from 2nd Platoon who is always checking out early. Doesn't he have kids who are always getting sick at school or his wife isn't supposed to drive or something?

PARTIAL TEXT . . .

"Complex vocabulary"
TTS



For example, if your self-learning includes a structured course, (PAUSE 1) the required learning resources may be provided to or identified for you. Additionally, choosing supplemental resources may be guided by the instructor or derived from course materials. For military subjects, the Army has invested heavily in creating courses that guide Soldiers toward success. However, (PAUSE 2) if your learning approach is more self-directed or independent, narrowing down and selecting learning resources may prove a bit more challenging. Let us examine some techniques that may help you assess available resources and determine those that may best suit your learning needs.

Promote Generative Processing – Embodiment (Human Likeness)

Images and photos have a positive impact on the learner when correctly used. On-screen agents (images of people/Soldiers and animated characters) greatly aid in the learning process when they display human-like gestures (movement, eye contact, and expressions). Training research indicates that human-like actions create a sense of social presence that learners relate to and react positively toward.⁷

The development of video segments with actors (professionals, volunteers, or Soldiers) can be resource intensive or cost prohibitive. However, the broadly distributed training simulation systems such as Virtual Battlespace (VBS) offer multimedia training developers unique capabilities to create realistic, editable scenarios and vignettes.⁹ These training simulation systems were designed to provide immersive, real-time, multi-user, exercises mimicking real-world situations. They have extensive content libraries providing personnel (military and civilian), equipment, static objects, and simulated effects to populate varied, editable scenarios.

For example, VBS3 features include U.S. Soldiers from all Services as well as 11 foreign militaries. It provides more than 200 civilian avatars of varied ethnicities, genders, and nationalities with realistic facial features. Content libraries include military and civilian models of nearly 300 tracked vehicles, 1,000 wheeled vehicles, more than 100 planes and unmanned air systems, and over 550 small arms and weapons. The scenarios, terrain, opposing force, and environmental circumstances can be varied to create the desired conditions to complement scenarios. Some facial expressions and gestures can be programmed into avatars and some models can be selected or programmed to act, react, or display actions associated with emotions and behaviors.

Scenarios and scenes can be converted to video and still photos using a variety of commercial image capture software suites for use in CBT. In short, you can use VBS systems to create and capture realistic still imagery and video to enhance your CBT.

(See the next slide for VBS model and avatar examples)

Promote Generative Processing – Embodiment

(continued)



Civilian Avatars



Urban Terrain, Civilian Equipment Models, and Programmed Conditions



Tropical Terrain, Varied Military Equipment and Camouflage Patterns, and Soldiers from Varied U.S. Military Services and Countries



Mountain Terrain, Military Equipment, and Flying Aircraft

Promote Generative Processing – Embodiment **WARNING**

(continued)

Take care to choose images and video that authentically portray the correct uniforms and equipment. Soldiers quickly challenge the accuracy and credibility of CBT content when dated uniforms, outdated equipment, or incorrect doctrine or tactics are used. Clearly identify the use of historic examples.



Woodland
BDU
early 1980s to
mid-2000s



UCP ACU
2004 to mid-2018



OEFCP-OCU
ACU
selective issue*
2010 to 2016



OCP ACU
issue begins
2015



M1 Abrams
Entered service
1980



M60 Patton
Entered service
1960



M14 7.62mm Rifle



M16 5.56mm Rifle M4



5.56mm Carbine

(See the next slides for video and still image examples)

Promote Generative Processing – Embodiment (continued)

Images and video segments may be edited and assembled to support your instructional design. Scenario frameworks should provide plausible situations. These situations should be ones that the learner can relate to with some familiarity, but they should be presented with some degree of uncertainty or unpredictability.

In these examples, still images are used to create the illusion of a conversation between two on-screen characters. Note that as the scene changes, varied postures and perspectives are used to provide the learner with an illusion of human-like movements. Voice inflections and emotions expressed in the dialog also become key to convey a true-to-life conversation. A recognized mentor or guide appears outside the scene to provide commentary and relate the scenario to learning objectives.

For the video (inactivated), segments from varied noncontiguous action scenes have been spliced together. This technique saves time since only action scenes are shown to the learner. Lulls and minor actions are omitted. This technique keeps the learner engaged with near constant action. Key actions and events are presented in the expected sequence of occurrence, a logical flow that the learner can relate to and follow without additional cues. The combination of varied still images and video create a sense of social presence. The learner can relate to the situation and the scenario.



Promote Generative Processing – Embodiment (continued)

For the second example (inactivated), a segment of an introduction is provided. Note the brief introduction by an unanimated “talking-head”. This transitions to a dialog between two on- screen agents or characters. Varied still images from different perspectives are used instead of animation (movements, changes to facial expressions, and gestures) to create a sense of social presence for the learner. These varied perspectives keep the learner engaged and are less resource and talent intensive than animation.

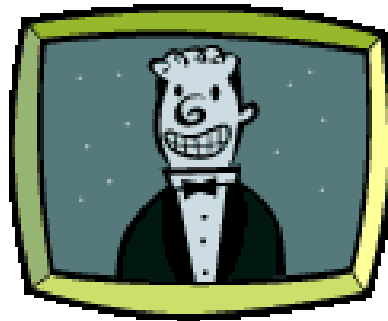


Promote Generative Processing – Image

Effective narration is essential to CBT. However, deep learning is not influenced by seeing a narrator or talking-head on the screen.⁷ In the days of black and white, three-channel network television (before home computers and cell phones), viewers were held spellbound by the nightly images of news anchors on their screen. Personalities like Chet Huntley and David Brinkley became icons, trusted to deliver accurate reporting and commentary.

However, times and learner expectations have changed, the same is not true for effective CBT. While an image or text on the screen during narration normally has a positive impact on the learner, static or talking-head images on the screen may cause distraction that detracts from any social benefit.

Timing is critical. If the talking-head performs a brief transition, it may be okay, but when it stays on the screen too long, interest fades. Generative processing is enhanced by meaningful images with supporting narrations.



**Talking-heads
alone (animated or
human) are
distractors and
seldom contribute
to learning.**

Assess Learning

Assessments can be used both as a gauge of the state or level of learner knowledge, skills, and understanding (summative) and as a measure of instructional effectiveness of training methods and media (formative). The same assessment tools can accomplish both purposes simultaneously.

When groups of learners fail to perform or perform poorly on assessments in selected skills or fail to display the desired level of knowledge or understanding of a task or subject, the training methods or media may be at fault. Learner performance or assessment responses may assist in formative assessment to pinpoint or diagnose training/instructional shortcomings.

However, for media and instructional methods that have been validated, three levels or types of summative assessments or tests may prove beneficial to the learners:

- A pre-assessment, before training to:
 - Identify learners requiring pre-training on essential foundation skills or knowledge
 - Support tailoring of training (to meet the learners where they are)
 - Determine a learning path
 - Mid-course assessments after chunks or modules to determine learner progress and to reinforce enabling learning objectives
- An end of training or post-training assessment to determine the learner's:
 - Level of proficiency
 - Attainment of standards
 - Retraining needs

These assessments may be verbal, hands-on, paper based, or embedded in the CBT.

Assessments are also a learning activity. They provide additional practice. However, to provide value, **all** assessments should provide feedback to the learner.

Provide Assessment Feedback

This example shows the use of a whole task evaluation. This technique provides feedback to support tailoring of initial training or retraining.

Training recommendations are based on the Assessment.

1. Designate/prepare/adjust primary individual/team/crew fighting positions to:		2. Designate/prepare: - Alternate positions - Supplementary positions (These positions should meet the same standards as primary positions.)		If all categories are a GO , congratulations, you have attained the standards for this lesson and may end training or elect to take selected topics. If you elect to end training, select NEXT to EXIT. If any elements of the task was assessed as a NO GO , the Recommended Training Topic or Topics have been illuminated. Upon completion of additional training you will be routed to the Post-Training Assessment. Suggested sections you should review: - Platoon and Squad Defensive Planning - Selecting Weapon Positions and Controlling Fires
Provide effective/adequate fields of fire.	✓	✗		
	✓			
Enhance Soldier/unit survival and safety.	✓	✓		
		3. Employ fire control measures effectively		
	✓	✓	✓	
	✓	✓	✓	
	✓	✓	✓	
Assessment Scoring: ✓ = GO ✗ = NO GO				

Recommended Training Topics

Select a topic to continue training.

Platoon and Squad Defensive Planning

Selecting Weapon Positions and Controlling Fires

Common Preparation Considerations

Prepare Machine Gun Positions

Prepare Antitank Weapon Positions

This frame depicts the results of the assessment. Note the dashed red box provides the recommended post assessment training topics. This recommendation to the learner is based on answer selections and missed questions.

This frame depicts all available training topics. Note the dashed red box in the previous frame recommended training topics. The learner would be free to explore any available topic.

This practice (with assessment) makes the best use of the students' time, focusing their learning on the subject areas or subtasks in which their demonstrated performance falls below standards or indicates shortcomings. It also rewards their good performance and shows where they meet standards.

Standards, weighted factors, and scoring thresholds can be adjusted in the programming to assure that learning goals are being attained.

Provide Assessment Feedback (continued)

Provide feedback for individual questions on selected tests and for checks on learning. Feedback should be provided in a manner that continues and reinforces learning. Reinforce correct responses. For incorrect responses, identify the error, indicate the correct response, and provide supporting key information to improve understanding.

The image displays three screenshots of a military training interface titled "Tailored Training: Adjust Indirect Fire". The central screenshot shows a question titled "Second Call for Fire Transmission" with a text box asking for the correct second transmission based on an FDC response. Below the question are four multiple-choice options: "Grid 415128, Over.", "NK 415128, Over.", "From my location at NK 415114, direction 360°, distance 1,400, Over.", and "Grid, NK415128, direction 0°, Over.". A green arrow points from the first option to the "Correct Feedback" screenshot, and red arrows point from the second and third options to the "Incorrect Feedback" screenshot. The "Correct Feedback" screenshot shows the selected answer "NK 415128, Over." as correct, with a green "CORRECT!" message and a detailed explanation of the grid method. The "Incorrect Feedback" screenshot shows the selected answer as incorrect, with a red "INCORRECT!" message and a detailed explanation of the correct grid method. Both feedback screenshots include a map of a desert landscape with a grid overlay and a target location marked with a red circle and the label "NK".

Second Call for Fire Transmission

The FDC responds, "This is F 73, Adjust Fire, Out." Which message, below provides the correct second transmission for the call for fire in this situation?

Grid 415128, Over.

NK 415128, Over.

From my location at NK 415114, direction 360°, distance 1,400, Over.

Grid, NK415128, direction 0°, Over.

HELP REFERENCE

Second Call for Fire Transmission: Correct Feedback

CORRECT! Your second transmission to the FDC provides the target location using the grid, polar, or shift from a known point method. The grid method was conveyed in the warning order. When the grid method is used, the coordinates should locate the target to the nearest 100 meters (six digits) and include the 100,000-meter grid square identification. Your selection was correct: "NK 415128, Over."

Your Call Sign: W 22
FDC Call Sign: F 73
Estimated location of the enemy: NK 415128

HELP REFERENCE Page 9 of 11

Second Call for Fire Transmission: Incorrect Feedback

INCORRECT! Your second transmission to the FDC must provide the target location using the grid, polar, or shift from a known point method. Your warning order indicated the grid method in the initial transmission. When the grid method is used, send a coordinate that locates the target to the nearest 100 meters (six digits) and includes the 100,000-meter grid square identification. The correct second transmission should be: "NK 415128, Over."

Your Call Sign: W 22
FDC Call Sign: F 73
Estimated location of the enemy: NK 415128

HELP REFERENCE Page 9 of 11

Test Design is a Key Element of Successful Assessment

The best methods of assessment generally involve live performance or demonstration of the knowledge or skill. However, time and other resource constraints may drive you to paper based or media embedded assessments. There are some simple rules that can be used to provide a rigorous assessment and maintain realism.

- As with all practice, problem based scenarios provide the best context for assessments.
- If the learner cannot actually or virtually perform the task, put the learner in the role of evaluating the performance, results, or products of others. Have the learner detect errors and problems, identify remedial actions, or determine correct solutions.
- Avoid memorization and regurgitation. Learners often “memory dump” memorizations that are not useful or necessary knowledge soon after training.
- Use question types in a manner that permits a demonstration of learner understanding:
 - True/False questions should be avoided.
 - Select multiple choice responses that are potentially confused with correct responses – eliminate throw away and illogical responses.
 - Use multiple or all correct responses for multiple choice questions.
 - Use “not used” responses or multiple correct responses for matching questions.
 - Avoid patterned responses.

Standards, weighted factors, and scoring thresholds can be adjusted in the programming to assure that learning goals are attained.

Assessment of Learning: Test Design and Question Examples

(continued)

These tests and their related questions (inactivated) provide examples of scenarios and problems related to skills that Soldiers would employ to find solutions to real-world problems. They assess the practical knowledge and skills that an Infantry Rifle Squad Leader or Fire Team Leader would require to be successful.

They also provide examples of balanced/parallel pre- and post-training tests. Varied situations and tasks examine proficiency in knowledge and skills without duplications.¹²

Squad Urban Defense



**Urban Def Test 1
(KEY)**



**Urban Def Test 2
(KEY)**



CFF Test 1 (KEY)



CFF Test 2 (KEY)

Engagement of Targets with Indirect Fire

Conclusion

Recent research indicates that there are practical principles that can enable the application of CBT for individualized training. Other principles exist for applying instructional design principles to CBT and for CBT instructional strategies. This Guide synthesizes and adapts these principles to Army instructional needs. The mission of the Guide is to bridge the gap between theory and practical application. It provides guidance and tools for Army trainers and training developers to support the design of effective CBT for military instructional purposes.

The Guide contains three primary sections:

- ADDIE Model – The accepted framework and guide for the design and development of effective CBT.
- Design and Development Principles – A series of easily-referenced fundamentals with examples that can lead to the design and implementation of more effective learner-centric training.
- Assessments – Fundamentals that support effective test design and feedback with examples of useful tests, questions, and feedback techniques.

The section on Design and Development Principles supports the development of effective CBT. The principles focus on generalizable strategies and are supported by relevant research literature, expert knowledge, and practical experience. Those Principles are summarized below:

- Define the learning task - what the learner should know or be able to do after instruction.
- Link new knowledge and skills to real world tasks and missions in context (problem based)
- Encourage practice of new knowledge and skills in context:
 - Provide varied situations, progressive levels of difficulty, and lessen instructional scaffolding as familiarity with task and steps increases.
 - Provide performance feedback and tailored remediation.

Conclusion

(continued)

- Provide content in logical chunks
 - ❑ Promote/manage essential processing
 - **Segmenting** - Present materials and animation in Learner-paced segments
 - **Pre-training** - Provide pre-training for essential basics and prerequisites
 - **Modality** - Present narrations vs. printed text
 - ❑ Reduce extraneous processing
 - **Coherence** - Avoid presenting extraneous materials
 - **Signaling** - Highlight essential materials
 - **Redundancy** - Do not add on-screen text to narrated animation
 - **Spatial Contiguity** - Place on-screen text next to corresponding graphics
 - **Temporal Contiguity** - Present corresponding narration and animation at the same time
- Provide a meaningful learning experience – promote generative processing
 - ❑ **Multimedia** - Present words and pictures rather than words alone
 - ❑ **Personalization** - Present words in a conversational style rather than formal style
 - ❑ **Voice** - Put narrations and dialog in human voice rather than machine voice
 - ❑ **Embodiment** - Have on-screen agent use human-like gestures and movements
 - ❑ **Image** - Do not necessarily put static image of agent on the screen

Footnotes

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APPENDIX B

User's Guide

User's Guide for Developing Computer-Based Training (CBT):

Considerations and Tips

Prepared by

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The Army Research Institute (ARI) constructed a summary of key principles to guide the development of effective CBT content. The “CBT Development Guide” (version 1.5) is presented as a Microsoft PowerPoint presentation. These principles are based on pedagogical theory, content, and learner issues. Adhering to these principles will yield content that will help students learn.

To address instructor concerns about formats, styles, and technical development, this document supplements the CBT Development Guide. This User's Guide includes some pre-development, developmental, some general design tips, and other considerations for the design and development process of building CBT modules. Much of this User's Guide material comes from human factor design standards (FAA¹ and NASA²) and from subject matter expert (SME) recommended internet sources^{3,4,5,6}. These materials provide a novice developer with some additional resources and materials to assist with the development efforts. This is not an exhaustive list.

Please keep in mind that while anyone can follow and comply with this User's Guide to help design and develop CBT, the learning value could be minimal or nonexistent if the learning principles outlined in the CBT Development Guide (v 1.5) are not used to guide the presentation of the content.

ARI's experience with CBT development and feedback from SMEs indicates that technical development and style design are very project specific. That is, CBT design and development is dependent on the goals and materials, knowledge, and skills to be conveyed to the learner. Further, SMEs agree that the design of a universal checklist or a step-by-step process for a novice to design and develop meaningful CBT is difficult if not impossible to compile. Taking this as a challenge, the following User Guide is only an attempt to consolidate a few good sources for the sole purpose of providing the novice developer some other mechanism to consider when developing CBT.

Pre-Development Considerations

Note: The below considerations parallel the guidance provided in the Systems Approach to Training analysis found in the Army TRADOC Pamphlet 350-70-6⁷ (Department of the Army Headquarters, 7 September 2004).

- **Define the target population**

The target population is the group of learners for whom the training is intended. It is critical to define this group in order to design the training appropriately. For example, training for officers would be very different from training for new Soldiers, even though they may do some of the same tasks. To define the target population, ask questions such as:

- What are the job titles of the intended participants in the training?
 - How were they originally trained for their jobs?
 - What are their educational and professional backgrounds?
 - Are they still in school or already on the job?
 - How are they accustomed to learning?
 - What languages do they speak and read?
 - What types of facilities do they work in, and how are these facilities equipped?
 - By whom are they supervised?
 - Is it possible for them to attend a training course away from their jobs?
- **List the tasks to be performed by the target population** (For the Army, official task analyses are performed by the Critical Task and Site Selection Board; see Army TRADOC Pamphlet 350-70-6 for more details⁷).

To list the tasks to be performed by the target population, one must know what “good performance” is; in other words, what a good performer would do on the job. To find out, the training developer must have access to:

- technical experts who can accurately describe the job,
- good performers who can be observed doing the job, and/or
- documents and manuals that accurately describe the job.

Through discussion with experts, observations, and review of documents, the training developer can develop a task list.

- **List the skills and knowledge needed to perform the tasks**

For each task involved in a job, the training developer should list the skills and knowledge required to perform the task. Skills are generally actions such as measuring, mixing, and recording, calculating, communicating, or making decisions. Required knowledge is the information needed to do a task correctly.

- **Select the skills and knowledge to be taught (i.e., the training objectives)**

Experts use a list of criteria to decide which skills and knowledge to include in the training. These will make up the training objectives for the course. The first list below shows factors that would lead to *inclusion* in the course; the second list shows factors that would suggest that the skill or knowledge could be *excluded* (not taught) in the course. Some of the factors may vary in relevance in different situations.

Possible criteria for *inclusion*

- Many members of the target population lack the skill or knowledge.
- Training (including practice and feedback) is required to learn the skill or knowledge because it is new or difficult.
- The task for which the skill or knowledge is needed is important to the outcome.
- The skill or knowledge is needed frequently.
- It is practical to teach the skill or knowledge in the given training setting.

Possible criteria for *exclusion*

- The task, skill, or knowledge cannot be described specifically and thoroughly enough to be a meaningful part of training. (This may be because of differences of opinion among technical experts, lack of authoritative evidence on how the task should best be done, etc.).
- Teaching the skill or knowledge is not practical in the time or with the resources available.
- Most members of the target population already have the skill or knowledge.
- The task, skill, or knowledge is straightforward and could be done correctly after reading guidelines, such as a checklist or manual. Practice and feedback are not required.
- The task is done or the skill/knowledge is used infrequently (e.g., it deals with a situation that is extremely rare).
- The task is done differently in different areas or other facilities (must be tailored to a unique setting).
- The task for which the skill or knowledge is needed is of low importance.
- There are substantial obstacles to doing the task (e.g., lack of equipment, tools, or time) that would prevent the learner from doing the task even if he/she knew how. These obstacles would have to be overcome before the training could be useful.
- Another training course is available to teach the task/skill/knowledge.

Similar criteria can be used to decide which of the included tasks, skills, and knowledge will receive more emphasis and practice in the training course.

Design Considerations

As part of the design process, the training developers organize the selected skills and knowledge to be taught into logical teaching units called modules. The design for each module includes its training objectives and a brief outline of the information, examples, and exercises that will provide opportunities for practice using the skills and knowledge (see CBT Development Guide).

The design of each module progresses from the brief design outline, to an expanded outline, to the complete module. Expanded outlines of the modules specify more completely the information and the types of examples and exercises to be provided. Examples might be given through pictures, live demonstrations, or video. Exercises might include written exercises, group discussions, role playing, or practice. To develop realistic examples and exercises, the training developers rely on interviews with technical experts who are familiar with the target population, job setting, tasks, and conditions.

- **Instructional modules**

An instructional module contains the teaching materials, such as text, pictures, video, etc. The design of instructional materials must involve the design of each individual item (text, graphics, audio, video, etc.) as well as ensuring that for each learning objective, the collection of instructional items form a coherent collection that will facilitate the student's learning (see CBT Development Guide for information on chunking, organizing, and sequencing material). Another consideration in the design of instructional modules is the detailed design of the various instructional materials for each learning objective. It is assumed that content design has preceded CBT design and has proceeded to the point that all learning objectives have been identified.

- **Formative tests**

A formative test is used to provide the student with a measure of an understanding of the subject being presented. In order to provide the student with frequent measures of understanding, formative tests should occur often and should cover small amounts of material.

Format of the presentation to the student, type of feedback, and timing of feedback are important design considerations. Some combinations of the following options are possible, but not all work well together and some induce significant development costs (see Development Consideration below).

- **Presentation options**

- One question per page
- All questions on one page with questions grouped according to type (T/F, fill-in-the-blank, multiple choice, etc.)

- All questions on one page with questions not grouped according to type (T/F, fill-in-the-blank, multiple choice, etc.)
- Separate pages for each type of question
- **Feedback options**
 - Correct or incorrect
 - Provide reward
 - Provide reward with additional challenge
 - Provide correct answer
 - Suggested remedial study
 - Provide remedial instruction
 - Provide score
 - Reasonable combinations of the above
- **Timing options**
 - After each question
 - After some predefined group of questions
 - After the test has been completed

The design of formative tests also requires a decision about how an individual test is constructed. For any given formative test, there are at least four choices for test construction:

- The same pre-constructed test is presented each time
- The test is selected (randomly or by rotation) from a collection of pre-constructed tests
- The test is constructed by randomly (this may involve weighting) choosing questions from a collection of questions.
- The test is constructed by assembling computer-generated questions
- **Evaluative tests**

Evaluative tests are primarily for reporting purposes. They are designed to evaluate and record the student's mastery of a subject. Evaluative tests occur less frequently than formative tests and evaluate the student's mastery of large blocks of the subject matter.

Development Considerations

- **Content development**

Developing course content consists of constructing and/or assembling teaching materials for each learning objective as prescribed by the design of instructional materials. Fundamental qualifications of persons performing content development include SMEs with a solid foundation in the principles of teaching and learning (see CBT Development Guide v1.5). Beyond these

two fundamental qualifications, the development team must possess expertise in the various media (writing, graphics, audio, video, animation, etc.) being used, as well as the computer tools used to create the media.

The cost information below may not be relevant to all designers. It is added here for general consideration purposes.

- **Development cost**

The cost of development is most frequently quoted in terms of development time required to develop 1 hour of CBT time, which itself is impossible to quantify. Estimates range from as low as 100 hours of development time per hour of CBT time to a high of 1,000 hours of development time per hour of CBT time. In most of these estimates, the cost of actually producing the media was not included in the estimate.

How does one calculate the cost of CBT development? The flippant answer is to try to calculate the cost after the project is complete. For a more acceptable answer, one should adhere to the following general guidelines during the design process and develop a cost estimate at the end of the design process.

- **Cost control guidelines**

These guidelines are generalities and it should be expected that each individual situation will impose its own unique modifications on these guidelines.

- Design the CBT system to meet its intended purpose.
- Adding an option will increase cost.
- Selecting options that the developer has previously implemented will reduce the cost increase.
- Changes late in the development process are extremely expensive.
- Experienced developers may use a higher base rate, but total cost is generally less than the total cost resulting from an inexperienced developer with a lower base rate.
- Every dollar spent on design saves three to five dollars in development costs.
- Computer program development is a creative process and not all time (costs) can be accurately predicted.
- Permit at least 10% of the total development cost to be devoted to testing the product

- Maintenance costs of a poorly designed or poorly implemented system can exceed the cost of initial development

For larger systems, it is generally cost effective to initially develop a comprehensive management system (content management, student management) so that no programming costs are involved in the development of the actual instructional modules. In a system consisting of 100 modules (hours of CBT time) or more, this approach should reduce total cost per module to the range of 50 hours per hour of CBT time.

Another consideration is to construct a development schedule. To construct such a schedule, the following considerations are important:

- Required resources
- Degree to which the instructor will participate
- Resources available from the instructor
- Resources available from the developer
- Events that are anticipated to interfere with development
- Marketing considerations

Although the needs and desires of the instructor are determining factors, the developer is able to provide realistic estimates of required time, and for that reason input may dominate during construction of the schedule. It should be clear from the descriptions above that both the instructor and the developer must be involved in the design of each component.

Checklist Options

The following material could be used by novice CBT developers for designing an in-house “style guide”, and may serve as a checklist to ensure the developed material complies with the CBT Development Guide.

- **Course organization**

Each course should include the following elements. Check off each item on the list as you address it:

- course title screen
- welcoming screen
- course menu that uses numbers or letters
- directions on how to use the CBT system, how to sign off, and how to return
- course objectives
- course prerequisites
- the duration of the course
- references to supporting materials such as workbooks or user’s guides
- an “escape” option to help the user exit from any screen or return to a screen

- completion status of each topic
- backward paging to give more control over the learning process
- an introductory screen containing the topic name, a brief description of the content, and a sentence or two of transition or orientation that links it to what has preceded it and what will follow it
- a list of objectives
- summary screens

In addition, course developers should keep the following points in mind. Again, check off each item on the list as you make sure you have addressed it:

- No unit should be longer than 20 or 30 minutes. Consider using menus and submenus to divide long topics.
- Avoid timed displays, even those that are timed to display for more than a few seconds. (The only exception is a timed display that builds a final image that remains on the screen until the student presses a key to move on.)

Timed displays are a problem for several reasons. For instance, students who turn away from the computer for even a few seconds may miss critical information; timed displays take control away from the learner. Also, they may distract slow readers by throwing new information onto the screen in different places. Further, they can frustrate faster readers who prefer to move at their own, speedier, rates.

- **Screen composition**

Each course should contain the following screen elements:

- unit or sub-unit identification—on the first screen of each unit or sub-unit
- a screen header and footer area, containing unit and screen numbers
- consistent fonts, type sizes, punctuation, and placement
- blank space at the top, bottom, and side margins to avoid clutter
- one main idea per screen
- bulleted lists of ideas
- paragraphs of no more than six to eight lines, if possible
- single spacing within paragraphs, and double spacing between the paragraphs
- no indents for paragraphs, except with bullets
- boxes containing instructional information, of the same size and in a consistent location on the screen
- typing directions in the boxes
- all-capital letters used only for warnings or hints.

- **Graphics and Fonts**

- Have you only used a maximum of four fonts throughout the entire course?
- Is the body text in the same font, and decorative text only used in the headers?
- Have you included the right line spacing and paragraph length?
- Have you used the correct font sizes and colors (are they all visible)?
- Is the body text left justified?
- Have you included a minimal amount of bold/italicized words?
- Are the images relevant, compressed and re-sized? Do you legally own all of them (or have copyright authorization)?
- Are all of the images the right file type and consistent (in terms of quality and size)?
- Are screen captures free of personal data and current?

- **Multimedia**

- Have you included relevant and legally owned (or copyright authorization) images and video elements in the course?
- Are all files compressed for easy download?
- Are all of the multimedia elements consistent (in terms of size and quality)?
- Is the audio synced to the video presentations?
- Is the narration clear and easy to understand?
- Have you ensured that the audio or video can be controlled by the user (e.g., paused)?

- **Accessibility**

- Have you used all of the ALT tags available?
- Are captions included for all audio or video elements that deal with core content?
- Are all of your fields and clickable areas easy to detect and use?

- **Navigation**

- Is the course easy to navigate for the learner?
- Can you easily navigate through the entire course using just the keyboard and mouse?
- Are all course modules featured in their correct sequence?
- Are hyperlinks displayed clearly and do they all work properly?

- Have you included backward links so that learners can return to previous screens?
- Is there an abundance of navigation graphics? If so, whittle down to only what is needed.
- Is there a table of contents and a map of the course?
- **Technical Issues**
 - Does the course load-up within a reasonable time frame?
 - Are shortcut keys available to the learner?
 - Do you have an FAQ page with hyperlinks to other areas of the course?
 - Have all hardware and software requirements and recommendations been listed?
 - Have the dimensions (display screen size) of the course been optimized for users?
 - Is the course viewable in all of the major web browsers?
 - Can selected pages (e.g., summary pages, or score sheets) be printed with ease?
 - Are assessments being scored properly?
- **Overall Design**
 - Do you have a clear syllabus in place at the beginning of the course?
 - Is the course aesthetically uniform and have you included branding elements throughout?
 - Is the color usage consistent and appropriate?
 - Are all of the elements visible with the chosen color scheme?
 - Does at least half the screen consist of white space, to keep the look clean and organized?
 - Have you verified that all content fits the screen (no horizontal/vertical scrolling)?
 - Have you avoided backgrounds/patterns that may be distracting for the learner?
 - Can instructors easily add or modify the content within the course?

Footnotes

¹Human Factors Design Standard; DOT/FAA/CT-03/05 HF-STD-001 (2003).

²Human Integration Design Handbook; NASA/SP-2010-3407/REV1 (2014).

³<https://www.questia.com/magazine/1G1-15611517/a-common-sense-checklist-for-cbt>

⁴<http://elearningindustry.com/the-ultimate-elearning-course-design-checklist>

⁵http://whqlibdoc.who.int/hq/2005/WHO_HTM_TB_2005.354_part1_eng.pdf

⁶<http://www.delweg.com/dpwessay/cbtdvlop.htm>

⁷<http://tradoc.army.mil/tpubs/pams/p350-70-6.pdf>

APPENDIX C

Design Assessment Worksheet for Interactive Multimedia Instruction (IMI)

**Design Assessment Worksheet
for
Interactive Multimedia Instruction (IMI)**

The purpose of this worksheet is to aid leaders, trainers and writers, training developers, and media technicians (artists and programmers) in assessing the design of interactive multimedia instruction (IMI). It is focused on assessing how effectively sound design principles and techniques have been integrated into the IMI to enhance learning.

Worksheet users should possess an understanding and working knowledge of the learning principles and techniques. The worksheet is designed to be used in conjunction with the **Computer-Based Training Principles Guide**, a research product of the U.S. Army Research Institute for the Behavioral and Social Sciences. For each “No” response, written remarks should be provided to cite specific examples or to provide recommendations for improvement.

1. Does the IMI state the Terminal Learning Objective (task, conditions, and standards) for the block of training (course, lesson, module, or topic) and/or the task(s) to be learned?

NO	YES
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Remarks:

2. Does the IMI state the Enabling Learning Objective (task, conditions, and standard) for the block of training (course, lesson, module, or topic) and/or the tasks(s) to be learned?

NO	YES
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Remarks:

3. Does the IMI relate new tasks (knowledge or skills) to previously learned tasks **OR** give a job-related reason to learn the task?

NO	YES
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Remarks:

4. Does the IMI present the instruction in the context of real world/job-related problems or tasks?

NO	YES
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Remarks:

5. Does the IMI provide the opportunity to practice/display the new knowledge or skill gained?
(Dedicated practice, user self-checks, checks on learning)?

NO	YES
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Remarks:

5. A. Does the IMI provide feedback for checks on learning, self-assessments, and practice?

NO	YES
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Remarks:

5. B. Does the IMI feedback include an explanation or information addressing the learner's errors or mistakes?

NO	YES
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Remarks:

5. C. If the user failed to meet the standards of the assessments, practice, or checks on learning, does the IMI allow the student to review the topic or receive retraining?

NO	YES
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Remarks:

5. D. Do the checks on learning, assessments, or practice present varied circumstances, situations, and problems in which the user can apply the new knowledge and skills?

NO	YES
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Remarks:

5. E. Do the checks on learning, assessments, or practice provide increased complexity or difficulty to provide or encourage the learner's confidence in the use of new knowledge and skills? (Crawl, Walk, Run)

NO	YES
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Remarks:

5. F. Does the IMI provide a post-test with feedback to determine student's level of proficiency?

NO	YES
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Remarks:

5. G. Does the post training assessment cover key teaching points, ELOs, and/or the stated performance standards?

NO	YES
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Remarks:

6. If the new knowledge and skills relate to subjects that the user has prior knowledge or related experience with, does the IMI provide a pretest or pre-training assessment to determine the level of user knowledge prior to training?

NO	YES
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Remarks:

7. Does the IMI provide or review "up-front" or prerequisite knowledge prior to getting into the details of task, knowledge, or skills? (Pretraining)

NO	YES
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Remarks:

7. A. If there are elements of knowledge or skills such as terms, part nomenclatures, tools, skills (or skill refreshers), or foundations that the learner requires, does the IMI provide them or references to them?

NO	YES
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Remarks:

8. Does the IMI present the topics, modules, or lessons in small manageable chunks, segments, or pieces? (Segmented)

NO	YES
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Remarks:

9. Does the IMI provide the learner with the means (navigation, replay button, etc.) to control the pace of presentation?

NO	YES
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Remarks:

10. Does the IMI present or convey the instruction in a conversational manner and tone - as a live person would if he was present and talking with or presenting information to the student? (Modality)

NO	YES
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Remarks:

10. A. Is the narration understandable? (Voice)

NO	YES
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Remarks:

10. B. Is the narration done in a conversational or “polite” style? (Could the user develop a social partnership with the narrator, or does it sound as though the narrator is reading instructions from a technical publication?) (Personalization)

NO	YES
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Remarks:

10. C. Does the narration avoid a verbatim reading of text displayed on the screen? (Redundancy)

NO	YES
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Remarks:

10. D. Is the narration synchronized with video clips, animation, and sequenced graphics? Does the narration match with and support what the user sees on the screen? (Temporal contiguity)

NO	YES
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Remarks:

11. Does the IMI stay on the topic and focus on learning objectives; is there a lot of “filler” or extra (nice to know) material? (Coherence)

NO	YES
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Remarks:

12. Does the IMI highlight important information in a topic and clearly delineate steps in processes? (Signaling)

NO	YES
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Remarks:

12. A. Does the IMI have some standard means to let the user know when something critical, essential, or important is being conveyed?

NO	YES
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Remarks:

13. Does the IMI label appropriate components in graphic displays in a nonintrusive manner, if or when required? (Spatial contiguity)

NO	YES
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Remarks:

14. Does the IMI provide a meaningful learning experience; does it include all the required learning material?

NO	YES
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Remarks:

15. Does the IMI present learning materials with graphics (images, animations, and video clips) and narrations, and present only limited or supplemental on-screen text? (Is multimedia used to convey learning or is it a book in a box?) (Multimedia)

NO	YES
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Remarks:

16. Does the IMI use a static “talking head”, on screen narrator, or agent for emphasis?
(Embodiment)

NO	YES
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Remarks: